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International Patent Application PCT/DE2004/002507

Title: Method for Structuring the Aerodynamics of Components in Aircraft Gas Turbines

Applicant: MTU Aero Engines GmbH

In response to the written notice of the International Searching Authority of March 18, 2005, which was sent along with the International Search Report:

Enclosed are new Claims 1 and 2, which are to be used as the basis for further international preliminary examination proceedings instead of the patent claims originally filed.

New documents and disclosure

The new Claim 1 includes the features of Claims 1 through 3 as filed originally and a feature from the description as originally filed, page 2, lines 8 through 11. These features have newly been assigned to the preamble and the characterizing part in accordance with the relevant prior art.

The remaining Claim 4 as filed originally with its reference back to a previous claim follows as a new Claim 2 with adjustment of the reference back to the preceding claim.

Novelty

The new Claim 1 is novel because the prior art documents cited disclose the production of an impeller in the BLISK technology in which the blades are machined by means of molded cathodes in an electrochemical machining process (in particular prior art document D3 but also European Patents 0 327 657 A1 and 0 292 213 A1) and also the structuring of the surface by means of electrochemical machining methods (in particular prior art documents D1 and D2), but simultaneous production

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of blades and machining of the surface of the blades combined in one manufacturing step, where the blades are machined to have a structure that is a negative of the molded cathode surface and minimizes boundary layers, is not disclosed in any of the prior art documents that have been cited.

Thus, none of the methods disclosed in the prior art documents cited have all the features given in the new Claim 1. The new Claim 1 is therefore novel in the sense of Article 33 (2) PCT.

Inventive step

Prior art document D3 discloses a method for producing blades arranged on the outside circumference of an impeller in the BLISK technology by contouring by means of an electrochemical machining method using molded cathodes. Owing to the change in alignment of the new application, prior art document D3 is thus to be regarded as the most proximate prior art.

The method of the new Claim 1 differs from the method known from prior art document D3 in that during the contouring, the surfaces of the blades are provided with a structure that is a negative of the molded cathode surface and at the same time minimizes boundary layers.

The technical effect of this is that the blades can be manufactured in one manufacturing operation, and by using the structurally modified molded cathodes it is possible to contour the blades and at the same time provide them with a structure that minimizes boundary layers.

The subjective object on which the invention is based is thus to modify a method according to prior art document D3 in such a way that the manufacturing process of the blades can be accelerated.

This object is achieved according to the present new Claim 1 in that the surface of the blades is provided with a negative structure in relation to the molded cathode surface, said structure minimizing boundary layers, and this is accomplished simultaneously in contouring in one manufacturing step.



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This approach was not self-evident for the following reasons:

Prior art document D3 – like European Patents 0 327 657 A1 and 0 292 213 A1 – discloses only how the blade blanks must be moved with respect to the cathodes in electrochemical machining to finish the aerodynamic contour of the blades. Because of the special geometry of the blades, the cathodes are shifted with respect to one another and also with respect to the blade blanks. Furthermore, the cathodes are rotated with respect to the blanks. However, these prior art documents do not contain any reference to machining of the blade surface with a negative structure in relation to the molded cathode surface and with a structure that minimizes boundary layers.

Prior art documents D1 and D2 disclose methods of electrochemical machining, i.e., renewing, of cooling channels. In this process, structures are formed in the cooling channels to create a turbulence in the cooling air flowing through the cooling channels. This turbulence should result in a more effective heat/energy transfer from the surface of the cooling channels into the cooling air to thereby improve the cooling effect.

To this extent, the structures disclosed in prior art documents D1 and D2 are not structures that minimize boundary layers, i.e., structures which, in contrast with the structures known from prior art documents D1 and D2, should specifically eliminate turbulence to increase the efficiency of the blades through a laminar turbulence-free flow. For this reason, surface structures that minimize boundary layers differ completely in their complexity from structures that produce turbulence in prior art documents D1 and D2.

Furthermore, the surfaces of the cooling channels in prior art documents D1 and D2 are structured by introducing the cathodes into the cooling channels but that are not in movement during electrochemical machining. In particular, otherwise it would not be possible to create the circular or linearly interrupted turbulence structures. For this reason, conductive and insulating areas are arranged side by side on the surface of the cathode. Movement of the cathodes would result in completely different surface structures in prior art documents D1 and D2 rather than the desired structures and therefore must not be performed.

From prior art documents D1 and D2, those skilled in the art would, in an attempt to solve the problem, derive the approach that the cathodes would not have to be moved in relation to the blades for structuring of the surface with a structure that minimizes boundary layers. Furthermore this would result in those skilled in the art not combining the two techniques for electrochemical machining of blade



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blanks disclosed in prior art document D3 and prior art document D1/D2 and instead would integrate into a single manufacturing step because, on the one hand, a relative movement would be necessary, but on the other hand, it would be harmful.

Based on prior art document D3 as the most proximate related art, those skilled in the art would therefore not arrive at the totality of features characterized in the new Claim 1. Therefore, a rotor blade according to the new Claim 1 is based on an inventive step according to Article 33 (3) PCT.

The remaining dependent Claim 2 relates to a special type of embodiment of the method according to the new Claim 1 and is therefore also novel and inventive.

MTU Aero Engines GmbH

[signature]

Dr. Söllner

Power of Attorney No. 48977

Enclosure

New Claims 1 and 2 (triplicate)

New Patent Claims

1. Method for manufacturing blades arranged on the outside circumference of an impeller in BLISK technology by contouring by means of an electrochemical machining method using molded cathodes, characterized in that the surface of the blades in contouring is equipped with a negative structure in relation to the molded cathode surface and at the same time a structure that minimizes boundary layers in one manufacturing step.
2. Method according to Claim 1, characterized in that the electrochemical machining method is a pulsed method.

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